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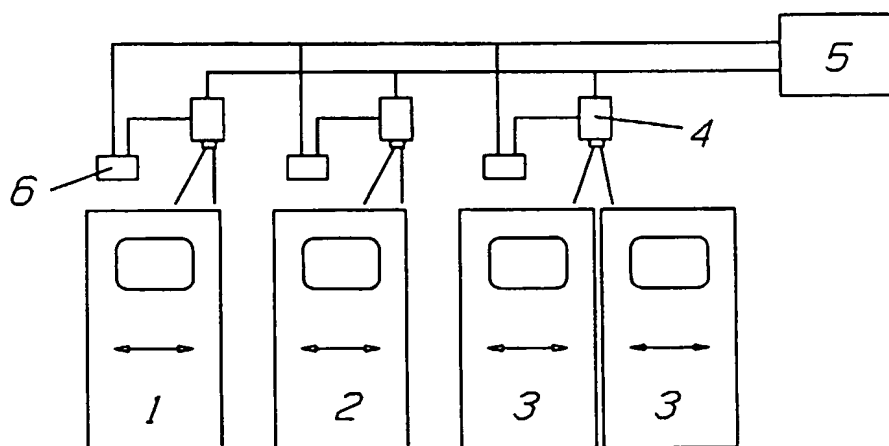
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(54) Title: **CAMERA SUPERVISED MOTION SAFETY SYSTEM**



(57) Abstract: A method and an apparatus in clamp protection systems (1-3) for doors and eventually existing footsteps (7) co-operating therewith, comprising a digital camera (4) at actual doors (1-3), which camera (4) is connected to a central computer (5) having a monitoring screen (5) to which also the ordinary opening and closing electronic means (6) are connected. Each camera transmits images at short intervals to the monitoring screen (5), each image is frequently compared with a reference image stored in the monitoring screen (5), and whereby alarm is given as soon as an image received from a camera (4) differs from the reference image of the monitoring screen (5), whereby the door (1-3) in question is opened or is maintained closed until the monitoring screen (5) observes that the received image coincides with the reference image.



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## CAMERA SUPERVISED MOTION SAFETY SYSTEM

The present invention generally relates to a safety system for doors and  
5 footsteps etc., in particular for use in trains, trams, buses, ships and other  
transport vehicles, but also for use with swinging doors, sliding doors, shutters,  
slidable roof valves etc. and for use in real properties, platforms and other places.  
The object of the invention is to avoid accidents which may occur if the doors are  
being opened or closed unintentionally while a person or an object is approaching  
10 the door or is present in the door opening, for instance so that the person or the  
object falls out or alternatively becomes clamped by the door or between the  
doors, or that the person becomes clamped at the rear edge of the door, or if a  
footstep is raised or lowered, respectively, or is expelled or retracted, respectively  
while a person or some object is approaching said footstep, or in co-operating,  
15 preferably synchronized footsteps and doors in a non allowed position while the  
door is being opened or is being closed, respectively.

For avoiding accidents at doors, footsteps and equivalent means there are  
at present generally used mechanical or electronic clamp protection means which  
are mounted in clamp ribs at the edges of the doors and which are formed with  
20 some types of switch mechanisms which stop the movement of the door, or inverts  
the door movement from closing to opening position if the clamp protection means  
is actuated.

The clamp protection means also may be formed with some type of touch  
free sensor, like an IR sensor or a similar means, which provides a corresponding  
25 clamp protection function. There are also other types of clamp protection means  
making use of inductive transmitters which scan the motion of for instance a cog  
wheel or a similar means, and which initiates the clamp protection function when  
the movement of such cog wheel is slowed down for the reason that the door leaf  
comes into engagement with some obstacle.

30 Most priorly known apparatus are formed so as not to give an indication  
until a person or an object is located in between the doors or between a door and  
a door frame and comes into physical contact with doors and/or door frames,

whereby the person or the object may be hurt or damaged. If such a system should fail this may have serious consequences.

The said priorly known systems also are not integrated with systems for monitoring expelling or retracting movements, respectively, of a foot step of the type which is presently used in buses, trains, trams and other places. The known systems normally also do not have any possibility of indicating if an object or a person is approaching the door, or to indicate the distance and/or the height between a foot step and a ramp, or the distance to the ground plane with respect to a vehicle and a platform or a railway or bus platform adjacent to which the vehicle is to stop.

Therefore there has been a need for a monitoring or supervising system, which is formed, considering its clamp protection system, so as to indicate

- when an object or a person is approaching a door that is under closing movement, or is eventually under opening movement,
- or which indicates and adapts the expelling length and/or the expelling height of a foot step or a walking bridge to the distance and/or the height to the ground or to a railway or bus platform, adjacent to which a vehicle is to stop,
- and which monitors that a foot step has been expelled or has been moved down before a door is opened, and
- that the footstep is not retracted until the door has been closed.

The invention is more particularly directed to such a safety system, in which there are used small monitoring cameras of the digital camera technique type which monitor the contours only of objects, and which have been implemented in the door or foot step system. The invention is intended to provide a monitoring or supervision thereby providing a safety in the clamp protection means operating so that, for instance

- no object or person is present close to, or is approaching a door which is being closed or is being opened;
- a foot step is expelled prior to opening of the doors and/or is not retracted until the doors have been fully closed;

- the foot step is expelled to an optimum position considering the differing distance between the vehicle and the platform or the height to the ground plane;
- the footstep is directed to a correct horizontal position considering how heavy or lightly loaded the vehicle is, and how high the platform or the debarkation place is located.

DE 196 19 688 and EP 0 853 299 disclose a method of acquiring an image of an operation area using a video camera for comparing, preferably at very short intervals, an actual camera image with an image which is stored in an image processor, and which allows a function of a working machine only when the actual camera image is identical to the image which is stored in the image processor.

In said known methods and apparatus the entire image is investigated concerning all details thereof, and therefore many data are analysed which are not relevant for an apparatus according to the present invention. A less amount of analysed data, as in the present invention, gives a safer monitoring. In the present invention there is no need for storing images of persons, and therefore the personal integrity is not affected. There is also no need for having personal supervision of one or more monitoring screens all the time but only when alarm is given. There is no risk of boring routines in the supervision process, and there are needed very little personnel and there is obtained a less supervision cost.

The system according to the present invention operates quicker and is a cheaper system than said priorly known systems since the system of the present invention makes use of fewer and cheaper system components.

The present system, which scans only contours of objects, indicate obvious changes of the image as compared with known systems in which a complete image is monitored in detail, whereby changes in the gray scale of the picture is monitored in small steps. This makes it difficult to distinctly determine whether or not the scanned reference points are identical. In the present invention, in which only a contour or a profile is scanned is safer and more exact.

EP 0 852 313 discloses a door supervising system comprising a CCD or a

video camera for monitoring the movement range of a sliding door and which is connected to evaluation device having a microprocessor to detect an obstacle in the path of the movement for the sliding door.

Said known patent suffers from the same disadvantages as those  
5 discussed above.

The invention makes use of so called "digital camera technique having automatic image treatment" of the same type as is used in digital reading pens which read the contours of text and send such information to a computer for various types of image treatment and other use, and in which the digital camera is,  
10 in this connection, used instead of a reading pen.

Thus, according to the invention the digital camera is scanning the contours only of an observed object or an observed person and is further observing and registering changes in the overall light conditions received by the digital camera. Therefore said camera operates quicker and safer and at less costs as compared  
15 with the discussed previously known systems.

According to the invention there are used small type, or very small type cameras mounted at strategic places, for instance obliquely above the door leafs and the footsteps, for detecting motions and/or changes in light, so as to thereby monitoring if there is some obstacle in the passage of the door and/or the  
20 footstep, or if an object is approaching the door leaf or the footstep while the doors are being opened or are being closed. In the system a reference image or picture showing the contours of a normal situation is compared with the contours of each actual image or picture obtained from a camera, and said actual images are analysed at given intervals, especially with a frequency of several images per  
25 second. Each image frame is analysed separately, and thereby there is obtained an indication of existing differences in relation to the reference image. It is also possible to see from the images where the door leafs and the footstep, respectively, are/is located, and a more close registration can be obtained the closer to each other the shutter doors come, and/or the closer the footstep comes  
30 to the platform or a similar structure while being expelled. Thereby it is possible to

check the position, even of small objects, before the door leafs and/or the footsteps are allowed to be locked.

By camera monitoring or supervision of the said type of the position of the door leafs or the footsteps, respectively, there is obtained a touch free clamp protection means. If a person or an object should be present between the door leafs during the closing movement thereof this is momentarily observed by one or more monitoring cameras, whereby the interconnecting electronic door activator foresees that the movements of the door leafs are stopped, or is preferably reversed into a movement in the opening direction. The camera system acts in common with already available electronic control means for the doors, and eventually also for footsteps of vehicles, thereby providing a double control means for the safety. The camera system operates by scanning contours of objects approaching a door and this gives a quick and safe detecting of objects and determination what is the object in question. Only shapes and motions of objects approaching the door are considered. On the contrary no alarm indication is given for objects moving away from the door or parallelly to the door.

The system can be applied to many different types of doors like swinging doors, sliding doors, shutters that can be opened, or footsteps, expellable walking bridges or ramps and many other types of supporting structures, or to combinations of doors and footsteps. The system is very useful and desired and can also be used in for instance driver-free rail vehicles or vehicles having automatic steering. The system is useful both for electric door openers and footstep apparatus, or corresponding hydraulic or pneumatic apparatus.

The advantages of the new monitoring system is that:

- the system monitors (supervises) the closing of the door and provides a touch free clamp protection means which is activated already before the door leaf comes into engagement with any obstacle,
- the door is opened automatically already before there is a risk of clamping,
- the door is opened when anyone is approaching a door during its closing movement,

- the closing movement of the door is however pursued when someone moves away from the door or parallelly to same.

The invention is diagrammatically illustrated in the accompanying drawings. Figure 1 diagrammatically shows, at the left part of the drawing two single doors and, at the right part of the drawing one twin sliding door which is/are monitored in common by means of a camera system according to the invention. Figure 2 shows a side view of the mounting of a monitoring camera for making a three-dimensional monitoring possible both of a door, a footstep or a ramp. Figure 3 is an algorithm explaining the function of the apparatus according to the invention.

Thus, figure 1 shows a monitoring system according to the invention, in which two separate doors and one twin door is/are monitored, namely two single doors 1 and 2 and one twin door 3 of sliding door type. Said doors can be mounted in trains, in trams, in buses, in ships and other transport crafts and can be arranged as inner doors and or intermediate doors of real properties, on platforms, on air ports and on many other places.

The monitoring system comprises a little monitoring camera 4 of digital type, in particular of the known type referred to as "digital camera technics having automatic image treatment" and of the type which is used, among other things, in reading pens and which reads the countours of text and sends said information in digital form to a computer, in the illustrated case a computer equipment having a monitoring screen 5, for different types of image treatment and other use.

Such cameras produce a large amount of images per time unit, often with a relatively great number of images per second, in which each image element can be built by a very large number of dots (pixels). The computer and the monitoring screen 5 builds up an image and looks for (scans) contours of people and objects, whether said people or objects are still standing or are moving. The monitoring screen 5 also observes changes in the light conditions of the object or adjacent same.

In the illustrated case a camera 4 of the said type is mounted at the upper edge of each door 1, 2, 3, and all cameras are connected to a common

computer/monitoring screen 5 which can be present in the drivers cabin of a train, a bus or another vehicle or at any other place to be monitored. At the same time the cameras 4 can be connected to the ordinary door electronic means for opening or closing of the door, respectively. It is also within the scope of the invention that the driver of the vehicle, or anyone, who wants to monitor the doors, can switch on any of the cameras for observing the positions of any of the doors or footsteps.

As shown in figure 2 the camera 4 can be mounted from inside obliquely downwards-outwards at the upper edge of a door, whereby the camera 4 can supervise both the opening phase of the door 1, 2, 3 and a footstep or a ramp 7 which is arranged to be fold out or expelled before the door is opened and to be retracted after the door has been closed. The camera also can observe the position of a platform, or of the ground plane under the door that can be opened. For making it possible that the camera, during the monitoring, should get at least a slight depth of field, so as to be able of monitoring both the movement of the door and the movement of the footstep, the camera can be placed in different ways from project to project.

As diagrammatically shown in figure 3 the monitoring takes place as follows:

A. Opening of a door:

When the vehicle has stopped, or in stationary door systems, the doors 1, 2, 3 normally can be opened without the risk of an accident. In the case that the door 1, 2, 3 is mounted on a vehicle and is eventually functionally interconnected to the footstep 7 it is important that the footstep is expelled (fold out) before the door is opened, so that there is no risk that the passenger be confronted with a too high step down from the train or the bus, or so that there is no space between the train or tram and the platform. As soon as the door has started being opened the camera 4 observes the position of the footstep 4, and if said footstep has not been fully expelled or fold out this immediately appears as a discrepancy at the continuous comparing process which is performed using the reference image



which is stored in the supervision screen 5. Alarm is thereby given on the supervision screen 5 and this has as an effect that the door is immediately closed again. The fault is attended to, in this case in that a renewed supervision checking is made that the footstep has been expelled. If this has not been done the door is  
5 kept closed.

B. Entering and leaving through the opened door can be done without obstacles until the door starts being closed.

C. When the doors 1, 2, 3 are busy being closed the camera 4 constantly observes the doorway and the eventually existing footstep, and if the camera  
10 thereby notifies a change of light, especially overall light, or a movement of any object in the doorway this is noted by the supervision unit 5 by as a discrepancy in a comparing the camera image with the respective reference image, and this has as an effect that the door is immediately opened again.

Concurrently with the supervision of the doorway there is made a  
15 supervision of the position of the footstep 7. If said footstep should start moving, or the footstep should for some reason be retracted, a corresponding alarm is given in the supervision unit 5, and the door is reopened. It is important a) that the footstep 7 co-operates with the doors 1, 2, 3, b) that said footstep is expelled or is fold down before the door is opened, and c) that the footstep 7 is not retracted or  
20 is not fold up until the door has been closed.

#### REFERENCE NUMERALS

- 1 door
- 2 door
- 25 3 twin sliding door
- 4 camera
- 5 monitoring/supervision screen
- 6 door electronic means
- 7 footstep, ramp

## CLAIMS

1. A method in a clamp protection apparatus and other safety systems for doors and footsteps etc., especially in vehicles like trains, trams, buses, ships and other transport crafts, in swinging doors, slidable doors, shutters, slidable roof valves etc., in real properties, in platforms and in other places for avoiding accidents which might otherwise occur if the doors are unintentionally being opened or are being closed while a person or an object is present in the doorway or is approaching the door, for instance accidents in that persons or objects fall out or is/are alternatively clamped between the doors or at the rear edge of the door, or if a footstep is raised or lowered or is expelled or is retracted, respectively, while a person or an object is approaching said footstep, or if co-operating, preferably synchronised footsteps and doors, is a non allowed position with respect to opening or closing, respectively, of the door, and in which there is used a monitoring (supervision) camera (4) of the type named "digital camera technics having automatic image treatment", which reads (scans) the contours of objects and transmits said information to a monitoring (supervision) computer (5) for different types of image treatment and other use, and in which such a camera (4) is mounted obliquely above each door (1-3) to be monitored, **characterized in**
- 20        that each camera (4) is connected to a central computer having a monitoring screen (5) to which also the ordinary opening and closing door electronic means (6) is connected,
- that the contour images are transmitted to the monitoring screen (5) at short intervals by each camera (4),
- 25        that said contour images from each camera (4) are frequently compared with a stationary reference image for the respective camera place, which stationary reference image is stored in the monitoring screen (5),
- and that alarm is given as soon as a contour image received from a camera (6) differs from the reference contour image of the monitoring screen (5), whereby
- 30        the door (1-3) in question is opened or is maintained closed, respectively, until the

monitoring screen (5) observes that the received contour image coincides with said reference image.

2. A method according to claim 1, **characterized** in that the monitoring camera transmits a large number of images per time unit, whereby each  
5 transmitted image is compared with the reference image of the monitoring camera (5).

3. A method according to claim 1 or 2, **characterized** in that each camera (4) scans the contours of an observed object or an observed person and changes in light conditions of, or around the observed object or the observed person.

10 4. A method according to claim 1, 2 or 3, **characterized** in that each camera (4) is mounted so that it can monitor both the doorway of the door (1-3) and the position of the footstep (7) or the ramp, or the distance to an adjacent platform, or the distance to the ground, and that the footstep (7) is expelled or is fold down before the door (1-3) is opened, and that the footstep (7) is not retracted  
15 or fold up until the door (1-3) has been closed.

5. Apparatus for executing the method according to any of the preceding claims, comprising a monitoring (supervision) unit for each door (1-3) and a computer having a monitoring screen (5), **characterized** in that the monitoring unit at each door is a camera (4) of the type named "digital camera technics having  
20 automatic image treatment" which is arranged to transmit information to the monitoring screen (5) for different types of image treatment and other use, and in which the camera (4) is mounted obliquely above each door (1-3) to be monitored.

6. Apparatus according to claim 5, **characterized** in that the monitoring screen (5) is formed with a reference image for each camera and its door, and in  
25 which each image received from the camera (4) is arranged to be compared with said reference image of the monitoring screen (5), and in which the monitoring screen (5), in case of an existing discrepancy between the camera image and said reference image, is arranged to give alarm resulting in a maintained closed position of the door, or alternatively an opening phase of a door which is being  
30 closed.

7. Apparatus according to claim 5 or 6, **characterized** in that the camera (4) is arranged to issue a large number of images per time unit, preferably between six and twenty images per second, and that the monitoring screen (5) is arranged to analyse each received image and to compare same with a reference image which is stored in the monitoring screen.

8. Apparatus according to any of claims 5-7, **characterized** in that each camera (4) is formed for scanning the contours of a monitored object and/or changes in the light conditions.

9. Apparatus according to any of claims 5-8, **characterized** in that it comprises a footstep or a ramp (7) the function of which is synchronised with the opening function of the doors (1-3), and in which the positions of both the doorway and the footstep or ramp (7) are scanned by the corresponding camera (4).

10. Apparatus according to any of claims 5-9, **characterized** in that each camera (4) is associated to the ordinary opening and closing electronic means (6) for the respective monitored door, having or not having a footstep (7).

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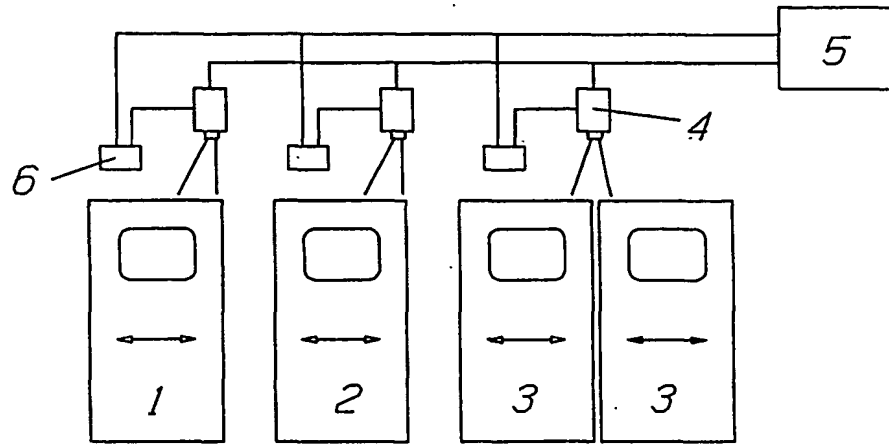


Fig. 1

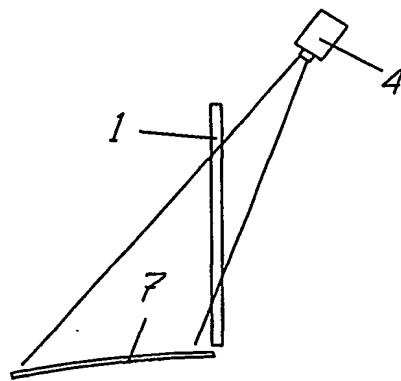


Fig. 2

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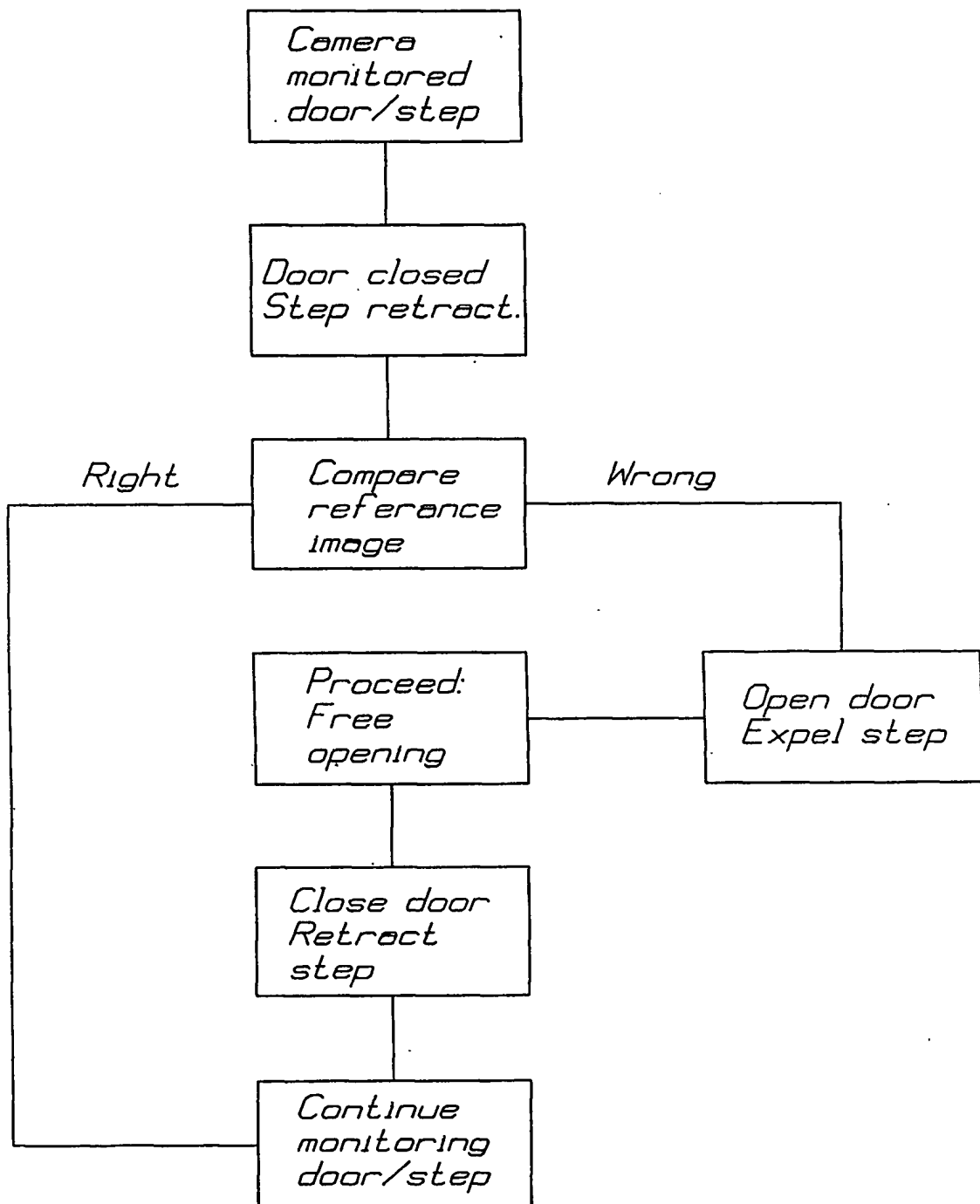


Fig. 3

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/02535

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E05F 15/20

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E05F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No.

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

28/01/02

International application No.

PCT/SE 01/02535

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